CLAIMS:

1. A photoacoustic spectroscopy sample array vessel comprising:

a vessel body having at least two sample cells connected to the vessel body, the sample cells having spaces therebetween;

at least one acoustic detector capable of receiving an acoustic signal from at least one sample cell; and

a material formed within the spaces, the material capable of enhancing transmission of the acoustic signal from the at least one sample cell to the at least one detector.

2. The sample array vessel of claim 1, wherein the material is an epoxy.

3. The sample array vessel of claim 1, wherein the material is a silicone-based material.

4. The sample array vessel of claim 1 further comprising at least one acoustic fin connected to at least one sample cell and the at least one acoustic detector such that an acoustic signal from the at least one sample cell can travel through the at least one acoustic fin to the at least one acoustic detector.

5. The sample array vessel of claim 4, wherein the at least one acoustic fin functions as the material formed within the spaces.

6. The sample array vessel of claim 1, wherein the at least one acoustic detector is affixed to the body.

7. The sample array vessel of claim 4, wherein the acoustic fin is formed of a material selected from the group consisting essentially of polystyrene, polyethylene, polypropylene, plastics with mineral fillers, plastics with metallic fillers, laminated carbon materials, metallic materials, and mixtures thereof.

8. The sample array vessel of claim 1, wherein the at least one acoustic detector is connected to a photoacoustic spectroscopy system and is connectable to the vessel body.

9. A sample vessel for PAS analysis comprising:

a body having multiple sample cells for holding samples for PAS analysis;

at least one acoustic detector positioned to detect acoustic signals that emanate from a sample in a sample cell; and

at least one acoustic fin acoustically connecting at least one sample cell to the at least one acoustic detector such that the acoustic signals are directed to the at least one acoustic detector through the at least one acoustic fin.

10. The sample array vessel of claim 9 further comprising at least one acoustic fin connected to each of the multiple sample cells and to the at least one acoustic detector.

11. The sample array vessel of claim 10 further including a separate acoustic fin connected to a respective sample cell.

12. The sample array vessel of claim 11, further including a collection bar to which the at least one acoustic fin is connected and to which the at least one acoustic detector is connectable.

13. A PAS sample array vessel comprising:

a body having sample cells for retaining samples, the sample cells having side walls and being arranged in an n, m matrix with rows of sample cells;

at least one acoustic detector positioned to receive acoustic signals from a sample in at least one sample cell; and

an acoustic fin extending along a row of sample cells such that the acoustic fin makes physical contact with the side walls of the sample cells in the row, the acoustic fin connectable to the at least one acoustic detector.

14. The sample array vessel of claim 13, further including separate acoustic fins extending along each row of sample cells such that the acoustic fins make physical contact with the side walls of the sample cells in respective rows, the acoustic fins connectable to the at least one acoustic detector.

15. The sample array vessel of claim 13, further including a collection bar to which the acoustic fin is connected, wherein the collection bar is connectable to the at least one acoustic detector such that acoustic signals may be directed from the acoustic fins to the collection bar.

16. The sample array vessel of claim 13, further including an acoustic collector lens to which the acoustic fin is connected, wherein the acoustic collector lens is connectable to the at least one acoustic detector such that acoustic signals may be directed from the acoustic fins to the acoustic collector lens.

17. A PAS sample array vessel comprising:

a body having sample cells for retaining samples;

at least one acoustic detector positioned to receive acoustic signals from a sample in at least one sample cell; and

means for directing acoustic signals from each of the sample cells to the at least one acoustic detector and for minimizing reflection of the acoustic signals.

18. A PAS sample array vessel comprising:

a body having multiple sample cells for retaining samples to be analyzed by PAS;

at least one acoustic detector centrally positioned on the body within a group of sample cells, to receive acoustic signals from a sample in at least one sample cell in the group; and

an acoustic fin having a first end connected to a sample cell and a second end connected to the at least one acoustic detector such that acoustic signals from the

sample in the sample cell are directed to the acoustic detector through the acoustic fin.

19. The sample array vessel of claim 18, further including multiple acoustic detectors each centrally positioned on the body within a group of sample cells, to receive acoustic signals from samples in each sample cell in a respective group of sample cells.

20. The sample array vessel of claim 19, further including separate acoustic fins extending from each sample cell in a group to a respective acoustic detector centrally positioned on the body within the respective group.

21. The sample array vessel of claim 18, wherein the sample cells have spaces therebetween, the spaces having acoustic material formed therein, the acoustic material enhancing the acoustic transmissivity of the sample array vessel.

22. A PAS sample array vessel comprising:

a body having multiple sample cells for retaining samples;

at least one acoustic fin having a first end connected to a sample cell and a second end connected to a collector bar; and.

at least one acoustic detector connectable to the collector bar to receive acoustic waves therefrom, the acoustic waves generated by a sample in at least one sample cell, the acoustic waves traveling through the at least one acoustic fin to the collector bar.

23. The sample array vessel of claim 22, wherein the collector bar includes a tapered end connectable to the at least one acoustic detector, the tapered end to focus acoustic waves received by the collector bar to the at least one acoustic detector.

24. The sample array vessel of claim 22, wherein the second end of the at least one acoustic fin includes a tapered end connected to the collector bar.

25. The sample array vessel of claim 22, wherein the first end of the at least one acoustic fin includes a tapered end connected to the ample cell.

26. A PAS sample array vessel comprising:

a body having multiple sample cells for retaining samples;

at least one acoustic fin having a first end connected to a sample cell and a second end connected to an acoustic collector lens; and.

at least one acoustic detector connected to the acoustic collector lens to receive acoustic waves therefrom, the acoustic waves generated by a sample in at least one sample cell, the acoustic waves traveling through the at least one acoustic fin to the acoustic collector lens.

27. A photoacoustic spectroscopy sample array vessel comprising:

a vessel body having multiple sample cells connected to the vessel body;

a reflection collector bar formed by the vessel body, the reflection collector bar positioned to receive acoustic waves generated by at least one sample in at least one of the multiple sample cells; and

at least one acoustic detector connectable to the reflection collector bar, the acoustic detector capable of receiving the acoustic waves from the reflection collector bar.

28. The sample array vessel of claim 27, further comprising an acoustic material formed in spaces between sample cells, the acoustic material enhancing the acoustic transmissivity of the sample array vessel.

29. The sample array vessel of claim 27, wherein the reflection collector bar includes a divot formed therein to reduce reflection of acoustic waves in the reflection collector bar and to direct the acoustic waves to the at least one acoustic detector.

30. A photoacoustic spectroscopy sample array vessel comprising:

a vessel body having multiple sample cells for retaining samples for analysis;

at least one acoustic detector connectable to the multiple sample cells to receive acoustic waves from the multiple sample cells; and

a support assembly supporting the at least one acoustic detector to maintain physical contact between the at least one acoustic detector and the multiple sample cells.

31. The sample array vessel of claim 30, wherein the acoustic detector is sized and shaped to fit about an outside wall of a sample cell.

32. The sample array vessel of claim 30, wherein the support assembly comprises a slotted flexible support bounding and supporting the acoustic detector.

33. The sample array vessel of claim 30, wherein the multiple sample cells include tapered walls.

34. The sample array vessel of claim 30, wherein the support assembly comprises a tensioning support.

35. The sample array vessel of claim 34, wherein the tensioning support comprises a clamp.

36. The sample array vessel of claim 30, wherein the acoustic detector comprises a cylindrical transducer sized to fit about an outside wall of a sample cell.

37. The sample array vessel of claim 30, wherein the acoustic detector comprises two hemicylindrical ceramic transducers.

38. A PAS sample array vessel comprising:

a body having multiple sample cells for retaining samples to be analyzed by PAS; and

at least one post collector centrally positioned on the body within a group of sample cells to receive acoustic waves from a sample in at least one sample cell, the at least one post collector capable of receiving an acoustic detector.

39. The sample array vessel of claim 38, further comprising at least one acoustic fin having a first end connected to a sample cell and a second end connected to the post collector such that acoustic signals from the sample in the sample cell are directed to the post collector through the acoustic fin.

40. The sample array vessel of claim 38, wherein the sample cells have spaces therebetween and further comprising an acoustic material formed in spaces between sample cells, the acoustic material enhancing the acoustic transmissivity of the sample array vessel.

41. The sample array vessel of claim 38, wherein the post collector further includes an acoustic detector attached thereto.

42. The sample array vessel of claim 38, wherein the detector is attached using a flexible support to maintain physical contact between the at least one acoustic detector and the multiple sample cells.

43. A sample array vessel for PAS analysis comprising:

a body having multiple sample cells for holding samples for PAS analysis; and

a transducer positioned at each sample cell to detect signals that emanate from a sample in a sample cell when exposed to an excitation source.

44. The sample array vessel of claim 43, wherein the transducers are positioned beneath the sample cell.

45. The sample array vessel of claim 43, wherein the transducers are connected to a base plate.

46. The sample array vessel of claim 43, further including integrated circuitry connectable to each transducer.

47. A sample array vessel for PAS analysis comprising:

a body having multiple sample cells for holding samples for PAS analysis; and

a reflective plate positioned beneath the sample cells, wherein the reflective plate is transmissive to acoustic waves and reflects light such that the reflective plate is capable of reflecting a light beam directed into a sample away from an acoustic detector without significantly impeding transfer of an acoustic signal emanating from the sample to the acoustic detector.

48. The sample array vessel of claim 47, wherein the reflective plate includes an upper surface and a lower surface, and an acoustic detector is positioned beneath the lower surface of the reflective plate.

49. A sample array vessel for PAS analysis comprising:

a body having multiple sample cells for holding samples for PAS analysis;

a transducer positioned at each sample cell to detect signals that emanate from a sample in a sample cell when exposed to an excitation source; and

a reflective plate positioned near the body to reflect a light beam directed into a sample away from a transducer, without significantly impeding transfer of an acoustic signal emanating from the sample to the transducer.

50. The sample array vessel of claim 49, wherein the reflective plate is positioned beneath the multiple sample cells and above the transducers positioned at each sample cell.

51. A PAS sample array comprising:

a body having at least three sample cells for holding samples for PAS analysis, the sample cells having an open upper end;

a sealing plate positioned to cover the upper portions of the sample cells such that the sample cells are substantially sealed from an outside environment; and

at least one acoustic detector acoustically connected to the sample array.

52. A PAS sample array vessel comprising:

a body having an array of sample wells for retaining samples therein;

a reflective plate connectable to a lower portion of the sample wells, wherein the reflective plate is transmissive to acoustic waves and reflects light;

a base plate having an array of acoustic detectors connected thereto, wherein the base plate is positionable below the array of sample wells such that the array of acoustic detectors align with a respective sample well in the array of sample wells.

53. The sample array vessel of claim 52, wherein the reflective plate is connected to the base plate.

54. A method for PAS analysis of analytes in a solution, the method comprising:

providing a sample array vessel having a matrix of at least three sample cells, the sample cells retaining solutions therein;

acoustically calibrating the sample array vessel;

exposing the solutions to a light beam to cause analytes in the solutions to emit acoustic signals; and

detecting the acoustic signals generated by analytes in the solutions.

55. The method of claim 54, wherein at least one transducer is used to detect the acoustic signals generated by the analytes.

56. The method of claim 54, wherein the acoustic signals generated by analytes in the solutions are detected using at least one contact transducer.

57. The method of claim 54, wherein the acoustic signals generated by analytes in the solutions are detected using at least one air-coupled transducer.

58. The method of claim 54, wherein the acoustic signals generated by analytes in the solutions are detected using at least one immersion transducer.

59. The method of claim 54, wherein the sample array vessel is calibrated by use of a standard solution.

60. The method of claim 55, wherein the sample array vessel is calibrated by use of the at least one transducer in a pulse-echo mode.

61. The method of claim 54, wherein the sample array vessel is calibrated by tapping the sample array vessel with a reproducible force to generate an acoustic wave and then detecting the acoustic wave.

62. A method for PAS analysis of analytes in at least one sample, comprising:

providing a microtiter plate having multiple sample wells;

acoustically calibrating the microtiter plate;

filling at least one of the multiple sample wells with at least one sample for PAS analysis;

acoustically coupling at least one transducer with the microtiter plate;

exposing the at least one sample to a light beam to cause analytes in the at least one sample to emit acoustic signals; and

detecting the acoustic signals generated by analytes in the at least one sample.

63. A method for PAS analysis of multiple solutions, comprising:

providing a sample array vessel having at least three sample cells for retaining solutions having analytes therein;

simultaneously exposing the solutions in the at least three sample cells to a light source to cause analytes in the solutions to emit acoustic signals;

placing at least one acoustic detector adjacent the sample array vessel; and

simultaneously detecting acoustic signals emitted by analytes in the solutions in the at least three sample cells.